Selectrodialysis of Mg^{2+} from seawater for phosphate recovery as struvite

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Background

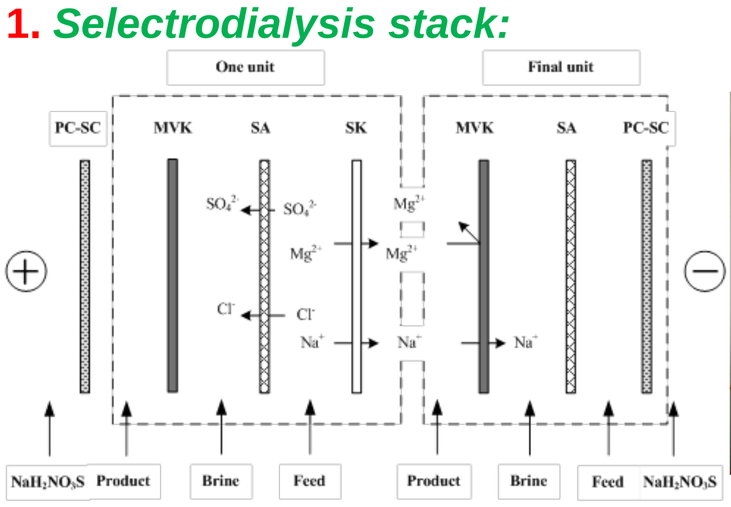
- Recovering struvite ($MgNH_4PO_4 \cdot 6H_2O$) from wastewater is an important option for phosphorus recycling.
- Magnesium source is one of the major limiting factors for struvite recovery.
- Seawater containing certain amounts of Mg^{2+} is an economically feasible magnesium source.

Objection

- A cation-selectrodialysis was developed to fractionate Mg^{2+} from seawater.
- Operation modes, working parameters and Ca^{2+} co-existence were investigated.
- Struvite recovery using fractionating Mg^{2+} as the magnesium source was conducted.

Methodology

1. *Selectrodialysis stack:*



2. *Selectrodialysis experiments:*

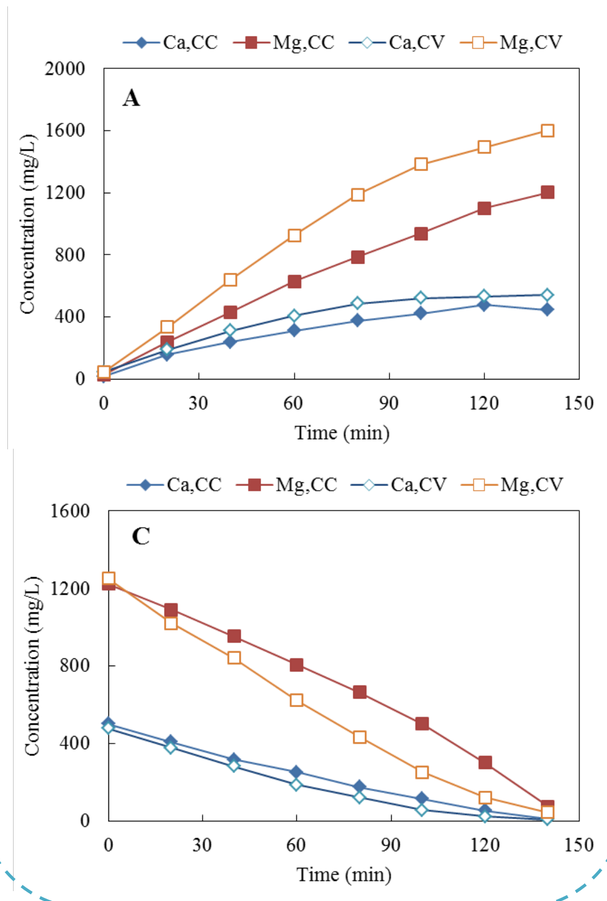
- Operation modes of constant current and constant voltage.
- Influence of voltage
- Influence of Ca:Mg mass ratio

3. *Struvite recovery:*

- The product streams were used as magnesium source for struvite recovery from wastewater.

Results

1. *Operation mode*



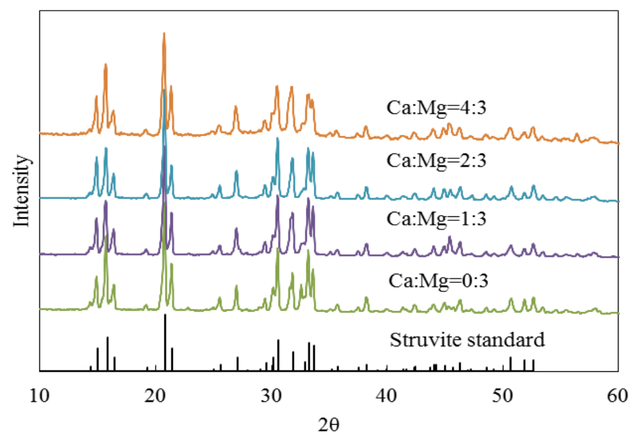
2. *Influence of voltage*

Voltage	Fractionation ratio (%)		S_B^A		E (kWh/kg $MgCl_2$)
	Mg^{2+}	Ca^{2+}	Na/Mg	Na/Ca	
7V	72.93%	55.69%	0.725	0.122	5.404
9V	74.17%	61.89%	0.802	0.563	8.883
11V	76.12%	64.48%	0.965	0.643	10.021
13V	80.48%	73.70%	0.962	0.669	11.694
15V	72.14%	65.15%	0.839	0.475	12.766

3. *Influence of Ca:Mg ratio*

Ca:Mg ratio	Fractionation ratio (%)		S_B^A			E (kWh/kg $MgCl_2$)	E (kWh/kg $CaCl_2$)
	Mg	Ca	Na/Mg	Na/Ca	Mg/Ca		
0:3	61.30%	-	0.817	-	-	9.106	-
1:3	68.22%	55.82%	0.804	0.577	-0.425	7.505	41.974
2:3	69.11%	62.14%	0.827	0.500	-0.558	8.342	20.894
4:3	74.48%	64.29%	0.875	0.534	-0.641	8.379	10.406

4. *Struvite recovery*



XRD diffractogram of the solids

Conclusion

- Mg^{2+} fractionation was achieved effectively by selectrodialysis.
- Ca^{2+} did not influence Mg^{2+} fractionation but reduced struvite recovery efficiency.

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